# Factors in Coronary Artery Disease

## Cigarette Smoking and Exercise

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• **A study was made of certain information from studies of the State Department of Public Health which bear upon the hypotheses that cigarette-smoking and physical exercise are factors in coronary artery disease. The data supported an association of the disease with cigarette smoking, but not with exercise. An incidental finding was a strong relationship between coronary heart disease and the beginning of the wearing of reading glasses or bifocals at an early age.**

**In the present state of investigations aimed at determining the etiology of coronary artery disease it appears desirable to give serious consideration to multiple factors rather than seeking to find a single cause.**

IN VIEW OF THE large and increasing number of deaths from coronary artery disease—it now causes about one-third of all deaths among men in California—every possible effort is needed to investigate causative factors.

All research arms, clinical, laboratory and epidemiological, must be called into play. And their combined endeavors should take into account one of the most difficult concepts in modern preventive medicine: The idea of multiple factors in causation of a particular disease. As a result of the many victories in the bacterial era of medicine, we have grown so accustomed to looking for the cause of a disease that we find it difficult to grasp the notion that a disease may have several causes. It is a struggle to keep in mind the possibility of *causative factors* rather than *the cause*.

This idea may perhaps be illustrated by the experience with so-called battle fatigue, personality breakdowns, in the North African campaign of World War II. What caused them? Some investigators find basic weaknesses in the psychic make-up of individuals affected and thus attribute the condition to personal inability to withstand the stress of severe battle. Other investigators point to the fact that the longer the men remained in combat the more likely they were to break down, and thus attribute the condition to excessive strain. Both types of factors —endogenous and exogenous—were undoubtedly involved. In various individual cases one or the other type of factor may have played the greater or lesser role. The man with little psychic reserve (or basic personality weakness) would break down early. On the other hand, almost every man, no matter how strong his personality, appeared to have some breaking point with longer and longer exposure to severe battle stress.

Coronary artery disease, also, may be a condition whose onset is determined by multiple factors, both exogenous and endogenous. In the search for causative factors in this disease at present, we suffer no dearth of hypotheses. One may even say that the hypotheses are so numerous that a particular fact may be "explained" by any of several of them.

A statement in the *British Medical Journal*[5] exemplifies this point: "Some years ago statistics were produced to show that coronary thrombosis fell heavily upon the learned professions because they bear the stress of responsibility, the clergy being protected by their spiritual tranquility. Later, when it became fashionable to regard our professions with less respect, similar statistics proved that coronary thrombosis was due to lack of exercise from traveling by car, the clergy being saved on bicycles. Now that cars are in general use, comparable figures prove that fat is our downfall, the clergy being spared by a leaner diet."

Today we are examining the data from several California studies which bear upon four hypotheses as to the etiology of coronary artery disease—fat, emotions, cigarette smoking and exercise. This communication will emphasize the latter two factors because of access to certain sources of data which bear upon them.

The first source consists of data obtained by follow-up observation of 3,994 longshoremen who received a multiphasic screening examination in 1951.[8] At the time of examination the men responded to a brief question concerning their cigarette-smoking habits. This permitted classification of the participants into two groups: Light or nonsmokers (less than a pack a day), and heavy smokers (a pack or more a day). The mortality rate from coronary artery disease in the two groups, observed during the five-year follow-up, was studied.

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From the Bureau of Chronic Diseases, California State Department of Public Health, Berkeley 4.

**TABLE 1.—*Coronary Artery Disease Mortality Rates per 1,000 Person-Years of Risk for Males by Age Group and Smoking Group Three Prospective Studies (Mortality Rates per 1000)***

| | Light and Nonsmokers* | Heavy Smokers† | Coronary Deaths per Person-Years: Light and Nonsmokers | Coronary Deaths per Person-Years: Heavy Smokers |
|---|---|---|---|---|
| **EXHIBIT A** | | | | |
| Buechley, Drake and Breslow:* (Longshoremen) | | | | |
| Age 35 to 44 years | 1.29 | 2.52 | 4/3100 | 6/2380 |
| Age 45 to 54 years | 1.63 | 4.55 | 7/4285 | 12/2635 |
| Age 55 to 64 years | 6.35 | 11.59 | 19/2990 | 16/1380 |
| Age 65 to 74 years | 10.26 | 9.52 | 12/1170 | 2/210 |

*Unpublished material.

| | Nonsmokers | Moderate Smokers | Heavy Smokers | Coronary Deaths per Person-Years: Nonsmokers | Moderate Smokers | Heavy Smokers |
|---|---|---|---|---|---|---|
| **EXHIBIT B** | | | | | | |
| Hammond and Horn (1958):[4] | | | | | | |
| Age 50 to 54 years | 2.71 | 5.43 | 6.79 | 90/33255 | 213/39226 | 203/29897 |
| Age 55 to 59 years | 4.31 | 8.78 | 10.65 | 142/32920 | 258/29385 | 199/18685 |
| Age 60 to 64 years | 7.33 | 14.02 | 14.11 | 204/27817 | 235/16762 | 129/9142 |
| Age 65 to 69 years | 12.47 | 19.66 | 19.44 | 273/21892 | 158/8037 | 73/3755 |
| **EXHIBIT C** | | | | | | |
| Doll and Hill (1956):[2] | | | | | | |
| Age 35 to 54 years | .44 | 1.47 | 1.84 | 5/11266 | 35/23751 | 28/15248 |
| Age 55 to 64 years | 7.34 | 4.45 | 6.98 | 14/1907 | 29/6514 | 36/5155 |
| Age 65 to 74 years | 11.13 | 10.53 | 14.85 | 12/1078 | 41/3893 | 34/2290 |
| Age 75 and over | 15.19 | 22.27 | 24.93 | 13/856 | 43/1931 | 18/722 |

*Includes those who smoke less than one pack a day. †Those who smoke more than one pack a day.

The other source of data is the California Health Survey, which covered a representative sample of Californians (about 32,000 persons), in 1954-1955.[1,3] Persons in whom coronary disease was disclosed in the survey (or by death later of this disease) were matched with controls of the same age and sex selected from the survey population. The controls and the persons with the disease were then reinterviewed (the next of kin was interviewed if the patient had died) to ascertain a number of characteristics which might be related to the coronary artery disease. In this reinterview, a question as to lifetime cigarette-smoking habits permitted classification of both the persons who had the disease and the controls into four groups: Nonsmokers; light smokers (a quarter or a half pack a day); moderate smokers (a full pack); and heavy smokers (more than one pack).

**TABLE 2.—*Data Showing Degree of Smoking—Light, Moderate or Heavy—Most Often Associated with Coronary Artery Disease (California Health Survey, Men, 64 Years and Under)***

| | Persons with Disease* | Controls* | Adjusted Ratio, Cases to Controls* |
|---|---|---|---|
| Total | 88 | 70 | |
| Reported amount of cigarette smoking: | | | |
| Nonsmokers | 12 | 20 | 1:2 |
| Light (¼ to ½ pack) | 14 | 13 | 7:8 |
| Moderate (1 pack) | 35 | 21 | 4:3 |
| Heavy (1½ to 2 packs) | 27 | 16 | 4:3 |

*The number of persons with the disease (88) and of controls (70) are sufficiently large for the usual statistical tests of significance. There are more cases than controls because the men reporting "heart disease" and those reporting no disease but dying of coronary disease were added after controls were selected. Ratios, as reported in tables, are corrected to adjust for the unequal numbers of cases and controls.

## CIGARETTE SMOKING

In Table 1, Exhibit A, the coronary artery disease mortality rate of the light and nonsmoking longshoremen is compared with that of the heavy smokers. Up to age 65 the coronary artery disease mortality rate in longshoremen who reported smoking a pack or more a day was roughly twice the rate in longshoremen who smoked fewer cigarettes or none at all.

By itself this finding might not be considered very impressive. However, it appears more significant when examined alongside the data from two other studies. Exhibit B in the same table shows the coronary artery disease mortality rates derived from the American Cancer Society study of Hammond and Horn,[4] and Exhibit C gives the rates from the study of English physicians by Doll and Hill.[2]

These coronary artery disease mortality rates show a remarkable similarity in their association with degrees of cigarette smoking. Further investigation of this association is being carried out on selected populations of Californians.

Additional evidence indicating an association between cigarette smoking and coronary artery dis-

TABLE 3.—*Data from Hegglin and Keiser[6] on Coronary Artery Disease Cases and Controls as Related to Cigarette Smoking (Men Under 50 Years)*

| | Persons with Disease | Controls | Ratio, Cases to Controls |
|---|---|---|---|
| Total | 153 | 151 | |
| Nonsmoker | 10 | 38 | 1:4 |
| Light smoker (less than 1 pack) | 79 | 81 | 1:1 |
| Heavy smoker (1 to 2 packs) | 49 | 28 | 7:4 |
| Very heavy smoker (more than 2 packs) | 15 | 4 | 4:1 |

ease comes from comparison of the group who had the disease with the control group in the California Health Survey study (Table 2). There were many more moderate to heavy smokers in the group with disease than in the control group. Also, among those who had the disease the incidence was higher in those who smoked a pack or more a day than in those who smoked less or not at all.

An even more striking relationship appears in the data of Hegglin and Keiser,[6] who made a comparison of controls and persons with coronary artery disease in Switzerland (Table 3).

We thus have data from two types of coronary artery disease investigations in California—a study of cases and controls in which the cigarette smoking data were secured retrospectively, and a study in which a population was first classified with respect to amount of cigarette smoking and then followed to determine subsequent mortality from coronary artery disease. Both types of investigations substantiated the association of coronary artery disease with cigarette smoking. Similar studies in other parts of the country and the world have yielded similar findings.

## EXERCISE

Another hypothesis receiving much current attention is that coronary artery disease occurs more frequently among persons who perform lesser amounts of physical exercise. Studies by Morris[7] and others have given credence to this idea.

Several questions were asked of the persons with coronary artery disease from the California Health Survey (and the control group) to test this hypothesis. The persons with the disease and the controls were classified according to whether they reported that their occupations entailed "much less labor" than the average, "a little less," "a little more" or "much more." Admittedly a crude measure, this classification revealed only a slight difference: The less heavy the work, the higher the coronary artery disease rate as compared with the controls (Table 4).

Another, somewhat less subjective, question was asked in a further attempt to ascertain the amount of physical exercise involved in occupations. Both

TABLE 4.—*Data on Reported Heaviness of Work as Related to Coronary Artery Disease (California Health Survey, Men, 64 Years and Under)*

| | Persons with Disease* | Controls* | Adjusted Ratio, Cases to Controls* |
|---|---|---|---|
| Total | 86 | 72 | |
| Much less labor | 30 | 23 | 1:1 |
| A little less labor | 22 | 11 | 5:3 |
| A little more labor | 18 | 21 | 3:4 |
| Much more labor | 16 | 17 | 3:4 |

*(See footnote, Table 2.)

TABLE 5.—*Relation of Reported Activity of Work to Coronary Artery Disease (California Health Survey, Men, 64 Years and Under)*

| | Persons with Disease* | Controls* | Adjusted Ratio, Cases to Controls* |
|---|---|---|---|
| Total | 89 | 68 | |
| 0 hours sitting (heavy) | 33 | 33 | 3:4 |
| 1 to 4 hours sitting (moderate) | 35 | 21 | 5:4 |
| 5 or more hours sitting (light) | 21 | 14 | 8:7 |

*(See footnote, Table 2.)

TABLE 6.—*Relation of Reported Participation in Sports to Coronary Artery Disease (California Health Survey, Men, 64 Years and Under)*

| | Persons with Disease* | Controls* | Adjusted Ratio, Cases to Controls* |
|---|---|---|---|
| Total | 80 | 60 | |
| 0 to 1 sport | 27 | 21 | 1:1 |
| 2 sports | 19 | 20 | 3:4 |
| 3 or more sports | 34 | 19 | 4:3 |

*(See footnote, Table 2.)

the persons with the disease and the controls stated the number of hours per day they sat while working. The groups were then classified (Table 5). Essentially no difference appeared when the data were examined in this way.

Many persons, of course, get a good deal of exercise away from the job. For information on the possible influence of this factor, the controls and the persons with disease were asked to list the sports in which they had participated as adults. Table 6 presents a rough classification based upon this factor. The data did not show any favorable influence from exercise of this type upon the incidence of coronary artery disease. If anything, the rate was higher for those who stated that as adults they engaged in three or more sports than it was among persons who reported less participation in sports.

In summary the data obtained as to exercise did not indicate any strong and consistent relation of heart disease to degree of physical exertion—on the job or off. It should be emphasized that the measures used to determine the degree of exercise were quite crude. However, if amount of exertion were a cru-

TABLE 7.—*Relation of Reported Age at Onset of Presbyopia to Coronary Artery Disease (California Health Survey, Men, 64 Years and Under)*

| | Persons with Disease* | Controls* | Adjusted Ratio, Cases to Controls* |
|---|---|---|---|
| Total | 70 | 55 | |
| Before 45 years (early) | 32 | 8 | 7:2 |
| 45 to 49 years (average) | 17 | 17 | 3:4 |
| 50 years and older (late) | 21 | 30 | 1:2 |

*(See footnote, Table 2.)

cial factor, even a crude measure would be expected to show some association. More work on this aspect of the subject is certainly needed.

### PRESBYOPIA

Of some interest in the study of factors associated with coronary artery disease is a finding that suggests a relationship with presbyopia, included in the study as a measure of physiological aging. The subjects in the series of persons with disease and persons used as controls were questioned as to the age at which they first used glasses for reading. If the persons had worn glasses during early adult life, the age when bifocals were first used was recorded; if they put on glasses, for reading only, during middle life the age was similarly recorded.

Undoubtedly many factors, of which presbyopia is only one, influence the age at which glasses are first used for reading. Others include motivation for reading and amount of reading, willingness to withstand discomfort in reading and various social factors. Hence the age of putting on reading glasses is merely suggestive of the onset of presbyopia, and the question, as asked, was a crude means of arriving at a measure of this condition.

Table 7 shows a rather striking association. Among persons with coronary artery disease, a large number had begun using reading glasses or bifocals before forty-five.

Before embarking upon extensive studies to explain this apparent association of presbyopia with coronary artery disease, it would be desirable to determine the relationship itself more certainly. The simplicity of the measure, and the apparent strength of the relationship seem to warrant such determinations.

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### REFERENCES

1. California State Department of Public Health, Health in California, 1958.

2. Doll, R., and Hill, A. B.: Lung cancer and other causes of death in relation to smoking: A second report on the mortality of British doctors, Brit. Med. J., 2:1071-1102, Nov. 1956.

3. Drake, R. M., Buechley, R. W., and Breslow, L.: An epidemiological investigation of coronary heart disease in the California health survey population, A. J. P. H., 47:43-57 (Part 2), April 1957.

4. Hammond, E. C., and Horn, D.: Smoking in relation to death rates, J. A. M. A., 166:1159-1172 and 166:1294-1308, 1958.

5. Heath, C.: Fallibility of statistics, Letter to Editor, Brit. Med. J., 2:1050, Nov. 1957.

6. Hegglin, R., and Keiser, C.: Uber Rauchen und Coranererkrankungen, Schweiz, Med. Wschr, 85:53-55, 1955.

7. Morris, J. N., and Heady, J. A.: Coronary heart disease and physical activity of work, The Lancet, Nov. 21, 1953, pp. 1053-1057; Nov. 28, 1953, pp. 1111-1120.

8. Weinerman, E., Breslow, L., Belloc, N., Waybur, A., and Milmore, B. K.: Multiphasic screening of longshoremen with organized medical follow-up, A. J. P. H., 42:1552-67, Dec. 1952.

## Social Security Footnotes

THOSE WHO SPONSOR Social Security regard professionals as a source of income and admit that most of them will never claim any benefits. Professional people are to be the source of funds to pay the "benefits" of others.

*—From the Department of Public Relations, American Medical Association*